Glass and Ceramics Vol. 63, Nos. 9 – 10, 2006

UDC 666.321

THE PRESENT AND FUTURE OF KAOLINS FROM THE ZHURAVLINYI LOG DEPOSIT

T. M. Argynbaev[1] and Z. V. Stafeeva[1]

Translated from *Steklo i Keramika*, No. 9, pp. 30 – 31, September, 2006.

The properties of kaolinites from the Zhuravlinyi Log deposit and the trends toward increasing production of concentrated kaolins from this deposit at Plast-Rifei Co. are reported The possibility of manufacturing quartz–feldspar concentrates based on the alkaline kaolins in this deposit at Plast-Rifei Co. is examined.

Proven world kaolin reserves constitute 14.8 billion tons. Most are concentrated in the USA, Great Britain, China, Ukraine, Brazil, and Australia.

There are 24 kaolin deposits with category A + B + C1 total proven reserves of 273,456,000 tons in the Russian Federation (Table 1). The kaolin deposits in Russia are represented by three basic genetic types: primary kaolin (7 deposits), secondary kaolin (11 deposits), and kaolin in quartz-kaolin-containing sands (6 deposits). The secondary kaolin deposits are located in Novgorod oblast, and the raw material is naturally concentrated, finely disperse clay rocks basically consisting of kaolinite, characterized by a high Al_2O_3 content (25 – 45%) and high refractoriness, up to 1800°C. The deposits of quartz-kaolin-containing sands are considered complex raw material (high-melting clays, glass sands, molding sands, kaolins). They are located in West Siberia, East Siberia, and the Far East kaolin-bearing territories. The primary kaolin deposits are located in the South Ural (Chelyabinsk, Orenburg, Sverdlovsk oblasts).

Of the 24 kaolin deposits, 8 are now being worked. Industrial mining of kaolin is done by five companies: Borovichi Refractories Combine, Nev'yansk Mine Management "Sverdlovsk Ceramics Ware Factory, Novokaolin MCC, Ksanta Co., Plast-Rifei Co. Concentrated kaolin is marketed by the last three companies.

The concentrated kaolin production volume for 2005 in Russia was 142,000 tons. Approximately half of the concentrated kaolin produced in the country is manufactured by Novokaolin MCC, and barely one-third is manufactured by Plast-Rifei Co. (see Table 1).

Production of concentrated kaolin is now increasing at Plast-Rifei Co. Revamping of the existing process line is being completed, and production is planned to increase by more than two times by the end of the year at Plast-Rifei, which would constitute approximately 100,000 tons of kaolin concentrate.

An exhaustive study of the reserves at Zhuravlinyi Log deposit has recently been conducted, and materials on the geology of the deposit are being readied for technical and economic substantiation of the conditions followed by accreditation of the reserves by the State Commission on Mineral Reserves after final correction of the volumes. Geological exploration work has almost been completed at the deposit.

The integral geological reserves, including high-grade varieties of kaolins, have been estimated at more than 37 million tons. Kaolins formed by weathering of leucocratic granites from the Povarnensk Massif predominate in the deposit within the limits of the mining concession. The upper horizons are usually normal kaolins, alkaline kaolins are found below, and gray, grayish-brown, high-iron, and highly alkaline kaolins are primarily in the lowest horizons and along the periphery.

Northern block kaolins have primarily developed along gneisses and crystalline shales. Apogneiss kaolins are primarily gray and gray-green in color, and a high kaolin fraction content (less than 63 μm), 64 ± 5% on average, is characteristic of them. In comparison to apogranitic kaolins, the content of free quartz is high in the kaolin fraction of kaolins based on gneisses, and the potash feldspar content is insignificant (sometimes totally absent).

In conducting the geological exploration work, three basic natural types of kaolins were distinguished in the deposit:

normal kaolins based on leucocratic granites with a ($K_2O + Na_2O$) content of less than 2% in the kaolin fraction;

alkaline kaolins based on leucocratic granites with a ($K_2O + Na_2O$) content in the kaolin fraction of less than 2%;

normal kaolins based on gneisses.

TABLE 1

Company	Production of concentrated kaolin, thousands of tons	
	2004	2005
Novokaolin MCC	70.5	77.5
Ksanta Co.	28.0	20.0
Plast-Rifei Co.	43.5	44.6
Total	142.0	142.1

[1] Plast-Rifei CJSC, Plast, Chelyabinsk oblast, Russia.

TABLE 2

Kaolin type	Content of fraction, %, size, μm			
	< 2	< 5	< 10	< 20
A	44.90	61.80	74.60	85.80
B1	43.60	57.10	69.85	79.73
B2	43.23	54.23	65.23	76.98
C	63.10	71.60	82.10	92.10

TABLE 3

Kaolin type	Water absorption, %, kaolin fired at, °C				
	800	900	1100	1250	1350
A	29.8	28.9	23.8	9.7	7.0
B1	26.7	26.0	16.4	4.3	2.4
B2	27.1	25.2	15.9	3.3	1.5
C	29.4	28.7	23.3	4.2	3.6

TABLE 4

Kaolin type	Bending strength, MPa, kaolin fired at, °C					
	100	800	900	1100	1250	1350
A	2.2	10.2	12.1	22.8	42.6	73.1
B1	2.8	18.1	21.8	60.7	73.5	104.4
B2	3.2	18.2	21.8	61.2	75.0	121.4
C	3.6	4.9	8.0	11.4	15.3	35.6

TABLE 5

Kaolin type	Total shrinkage, %, kaolin fired at, °C					
	100	800	900	1100	1250	1350
A	4.0	5.1	5.6	8.4	12.9	14.6
B1	4.4	5.0	5.8	10.9	14.2	15.4
B2	4.8	5.4	5.7	10.9	14.7	15.7
C	5.4	6.7	8.0	10.8	16.9	17.2

The material composition and process properties of all types of kaolins in the deposit was investigated in depth. The process properties of the kaolin fraction of these types of kaolins were comparatively analyzed.

It was found that the normal kaolins formed from gneisses are the most finely disperse; the normal kaolins based on granites are less disperse; alkaline kaolins are the most coarsely disperse of all the existing types.

If we compare the ceramic properties of alkaline and normal kaolins, the highest bending strength in samples fired at different temperatures is characteristic of alkaline kaolins. The highest strongly sintered kaolins are the alkaline kaolins, and water absorption is 3 – 5% at 1250°C. Normal kaolins have water absorption of 8 – 10% at this temperature. The highest shrinkage at different firing temperatures is characteristic of the alkaline samples of the kaolins.

The disperse composition of the different natural types of kaolins from the Zhuravlinyi Log deposit is reported in Table 2.

Normal kaolins developed from granites belong to type A; alkaline kaolins from granites with a kaolin frication content ≥ 50% belong to type B1; alkaline kaolins from granites with a kaolin fraction content of < 50% belong to type B2; normal kaolins from gneisses belong to type C.

The ceramic properties of the kaolin fraction < 63 μm in size from the Zhuravlinyi Log deposit are reported in Tables 3 – 5.

Normal kaolins from gneisses have the highest dispersion and alkaline kaolins can be assigned to coarsely disperse. The higher the content of alkalis ($K_2O + Na_2O$) in the kaolin fraction, the coarser the dispersion of the kaolin, the better it sinters, and the higher the shrinkage and mechanical strength of the kaolin samples fired at different temperatures.

The Analytical-Process Certification Testing Center at the All-Russian Scientific-Research Institute of Geology of Nonmetallic Minerals FGUP (Kazan) is currently conducting an in-depth study of kaolins of different natural types in the Zhuravlinyi Log deposit. The discrepancies in the correlation of the ceramic properties and disperse composition (in particular, the higher the dispersion in these kaolins, the lower the bending strength) are due to the structural features of the different natural types of kaolins.

The classic method in preparation of ceramic paste provides for use of different grades of kaolins with different process properties which should complement each other. Such a kaolin composition can be created at the Zhuravlinyi Log deposit. Selective mining by types and grades and blending during warehousing with consideration of the process properties of the kaolins allow creating a kaolin composition that best satisfies the requirements of the different branches of industry that utilize kaolin from this deposit.

Based on the principles of rational utilization of raw materials and since a low yield of kaolin concentrate is obtained in concentrating alkaline kaolins, the concentrators have proposed additionally separating quartz-feldspar concentrate. According to the preliminary calculations of geologists, the kaolin reserves from which such concentrate can be extracted allow considering creation of the required technology.

The method of obtaining a kaolin-quartz-potash feldspar composition consists of using two-stage classification of the kaolin raw material: first – based on the boundary grain of the 200 μm classification with separation of product less than 200 μm; second – concentration based on 20 μm, i.e., separation of the less than 20 μm fraction, which is a kaolin constituent. The kaolin-quartz-potash feldspar composition is thus a product separated from kaolin raw material based on 20 – 200 μm separation boundaries.

The chemical composition of the product (mass content, %) is: 63 – 66 SiO_2, 20 – 23 Al_2O_3, 7 – 10 K_2O, 0.2 – 0.5 Na_2O, under 0.3 Fe_2O_3. The mineral composition is (mass content of basic components, %): 45 – 55 potash feldspars, 30 – 35 kaolinite, 13 – 20 quartz. The granulometric composition is: 20 – 30% content of less than 20 μm fraction.

The concentration product obtained in laboratory conditions has now passed factory tests at some ceramics companies and positive results have been obtained in using it.